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Dated: 4 July 2000

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Request for grant of a patent

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The Patent Office

Cardiff Road
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1. Your reference

FPW/P92746GB

2. Patent application number
(The Patent Office will fill in this part)

9913600.4

12 JUN 1999

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Sensor Highway Ltd
Roman House, North Way
Walworth Industrial Estate
ANDOVER, Hampshire, SP10 5QD

Patents ADP number *(if you know it)*

7641574001

If the applicant is a corporate body, give the country/state of its incorporation

England and Wales

4. Title of the invention

OPTO-ELECTRICAL ACTUATION SYSTEM AND METHOD

5. Name of your agent *(if you have one)*

Urquhart-Dykes & Lord (Reading)

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

1 Richfield Place
12 Richfield Avenue
Reading
RG1 8EQ

Patents ADP number *(if you know it)*

1644027

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	4
Claim(s)	2
Abstract	1
Drawing(s)	1

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Urquhart-Dykes & Lord Date 11 JUN 1999

Urquhart-Dykes & Lord (Reading) - Agents

12. Name and daytime telephone number of person to contact in the United Kingdom

Mr F P Wolff 0118 950 9937

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Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.*

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d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

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OPTO-ELECTRICAL ACTUATION SYSTEM AND METHOD

This invention relates to an opto-electrical actuation system and method. Specifically, it relates to a system and method in which light is used to selectively actuate and control a plurality of electrical devices. References to actuation herein are intended to include controlling and/or supplying operating power to the devices.

The system and method in accordance with the invention are intended to supply electrical power at an effective actuating voltage selectively to one or more of a plurality of devices. The power may be used to switch the devices, or to supply running power to them, according to the demands of the devices and the availability of other electrical power sources.

The invention is particularly suitable for downhole use at oil and gas exploration and production sites, in environments where temperatures can reach up to 300°C.

In accordance with one aspect of the invention, there is provided an actuation system for a plurality of electrically actuated devices, comprising a pulsed light source of variable pulse frequency directed to a plurality of actuation gateways each adapted to supply an electrical actuation voltage above a threshold value to an associated device when illuminated by light pulsed at a trigger frequency for that device.

Each said gateway is suitably provided with an optical sensor such as photovoltaic converter means for converting pulsed incident light to a pulsed electric current of corresponding frequency. Frequency sensitive transformer

means may be provided for transforming the voltage of the pulsed current to a higher voltage above the threshold value for the associated device when the current frequency is at a trigger frequency. The transformer means may be a piezoelectric transformer and the trigger frequency is then suitably a resonant frequency of the piezoelectric transformer.

The trigger frequency may be in a band of not more than about 3 KHz within the range 10 KHz to 40 KHz. The trigger frequencies of devices to be operated independently are suitably separated by about 3KHz or more.

The system desirably includes optical pathway means for directing light from the light source to the plurality of actuation gateways. The optical pathway means may comprise a branched network of optical fibres connected by optical couplers.

The invention further provides a method of actuating a plurality of electrical devices which comprises providing an actuating system for the said devices as set out above, and selectively actuating a device by illuminating the actuation gateways with light pulsed at a frequency that corresponds to the trigger frequency of the selected device.

One embodiment of the invention is illustrated by way of example in the accompanying drawing, which illustrates diagrammatically an actuation and control system in accordance with the invention.

As shown in the drawing, a single light source 10 is connected to an optical fibre backbone 12, along which a series of optical couplers 13 make optical connection between the backbone fibre and branch fibres 14. Light pulsed from the light source is conducted by the optical network (12, 13, 14) throughout the system.

Branch fibres 14 deliver light to actuation gateways each associated with an

electrical device 20. Each gateway comprises a photovoltaic converter 16 and a piezoelectric transformer 18. The devices 20 could be, for example, pilot valves, solenoid valves, motors and electrically powered instrumentation.

Each photovoltaic transformer 18 has a natural resonant frequency range of, typically, 3KHz or less. When provided with pulsed electrical current at a resonant frequency, the transformer increases the voltage to a value that is above a threshold value required to actuate the electrical device 20. If pulsed current is supplied to the transformer 18 at a frequency outside its resonant trigger frequency range, the voltage increase is low, and does not reach the threshold value.

The photovoltaic converter 16 at each gateway responds to incident light transmitted over the optical network from light source10 and converts it into electrical current of a corresponding pulse frequency. Accordingly, the pulse frequency of the light emitted by the light source determines the frequency of the electrical current applied to all the transformers 18 in the system at the same time.

In accordance with the invention, electrical devices 20 that are intended to operate simultaneously are associated with actuation gateways in which the transformers 18 have similar resonant trigger frequencies, and electrical devices that are intended to operate independently are provided with actuation gateways in which the transformers have distinctly different resonant frequencies. In this way, the devices to be actuated can be selected by appropriate selection of the pulse frequency at the light source.

Typical operating frequencies of a series of devices in accordance with the invention are 13-16KHz for the first device, 18-21KHz for the second device, and so on, with each device having a 3KHz trigger frequency band with a 3KHz separation between bands.

As an example, the output voltage of the photovoltaic converters 16 may be about 6V. If, and only if, the light pulse frequency is such as to produce an electrical frequency in the resonant trigger band of the transformer 18, the transformer output may be 600-800V, sufficient to actuate the associated electrical device.

CLAIMS

1 An actuation system for a plurality of electrically actuated devices, comprising a pulsed light source of variable pulse frequency directed to a plurality of actuation gateways each adapted to supply an actuation voltage above a threshold value to an associated device when illuminated by light pulsed at a trigger frequency for that device.

2 A system according to claim 1 wherein each said gateway comprises photovoltaic converter means for converting pulsed incident light to a pulsed electric current of corresponding frequency.

3 A system according to claim 2 wherein each said gateway comprises frequency-sensitive transformer means for transforming the voltage of the pulsed current to a higher voltage above the threshold value for the associated device when the current frequent is at a trigger frequency.

4 A system according to claim 3 wherein the transformer means comprises a piezoelectric transformer and the trigger frequency is a resonant frequency of that transformer.

5 A system according to any one of the preceding claims in which the trigger frequency is a band of not more than about 3KHz within the range 10KHz-40KHz.

6 A system according to any one of the preceding claims in which the trigger frequencies of devices to be operated independently are separated by at least 3 KHz.

7 A system according to any one of the preceding claims comprising optical

pathway means for directing light from the light source to the plurality of actuation gateways.

8 A system according to claim 7 wherein the optical pathway means comprises a branched network of optical fibres connected by optical couplers.

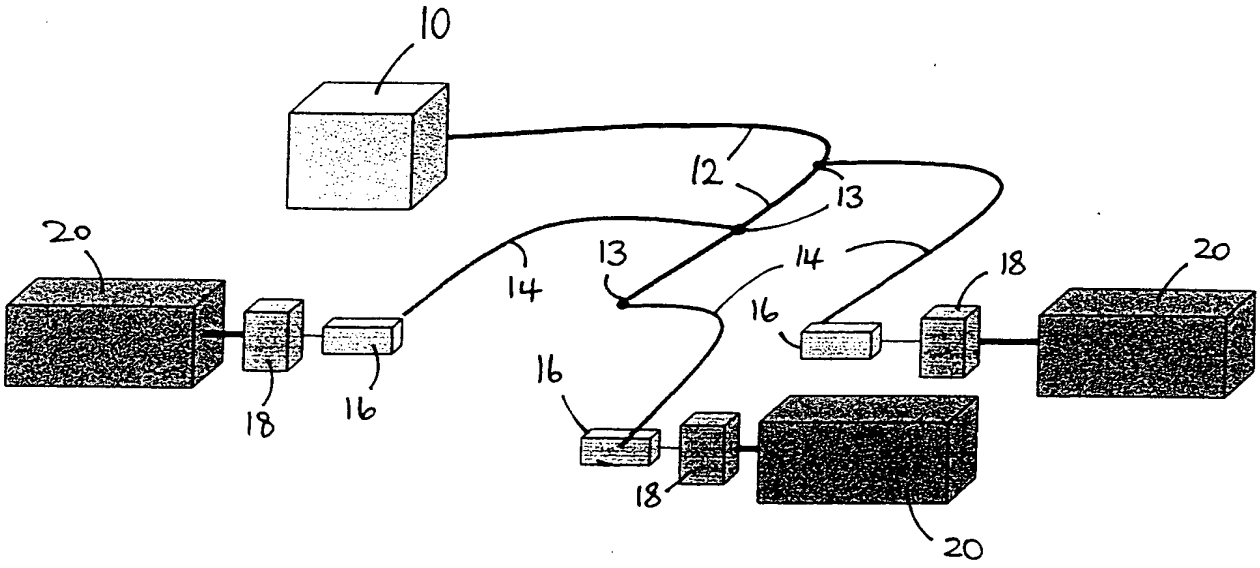
9 An actuation system for a plurality of electrically actuated devices substantially as herein described with reference to and as illustrated in the accompanying drawing.

10 A method of actuating a plurality of electrical devices, comprising providing an actuation system for the said devices according to any one of the preceding claims, and selectively actuating a device by illuminating the actuation gateways with light pulsed at a frequency that corresponds to the trigger frequency of the selected device.

ABSTRACT

OPTO-ELECTRICAL ACTUATION SYSTEM AND METHOD

A selective optical actuation system for a plurality of electrical devices (20) comprises a variable pulse frequency pulsed light source (10) and an optical fibre network (12,13,14) distributing the light pulses to an actuation gateway for each device, comprising a photovoltaic converter (16) whose correspondingly pulsed electrical output is applied to a piezoelectric transformer (18). Only if the pulse frequency is within the resonant band for a given transformer will the voltage be raised above a threshold value required to actuate that device. Choice of light pulse frequency thereby determines the device(s) to be actuated.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